NDnano Summer Undergraduate Research
2016 Project Summary

1. Student name: Frances Ryan

2. Faculty mentor name: Alison Deatsch, Prof. Steven Ruggiero, Prof. Carol Tanner

3. Project title: Light Transmission Spectroscopy for the Sizing of Nanoparticles in Suspension

4. Briefly describe any new skills you acquired during your summer research:
My project involved becoming familiar with Light Transmission Spectroscopy a method for finding the particle size distribution of nanoparticles of sizes ranging from 5nm to 3000nm. My work involved a lot of calculations for using in a practical lab setting as I was required to carry out serial dilutions of the nanoparticle suspensions. I also had to incorporate mechanical separation techniques in order to assess the best method for detecting the presence of nanoparticles in mixtures.

5. Briefly share a practical application/end use of your research:
By assessing the limitations and capabilities of the LTS system using polystyrene beads which have similar dielectric properties to organic materials we aim to use the methods we develop to determine the particle size and density of unknown environmental and biological samples.

Begin two-paragraph project summary here (~ one type-written page) to describe problem and project goal and your activities / results:

Laser Transmission Spectroscopy (LTS) is a method for determining the size and density distributions of nanoparticles in solution. LTS makes use of a wavelength-tunable lightsource to measure the wavelength dependent extinction of particles in an aqueous solution, and this is inverted using a Mie model in order to obtain the particle size distribution. The method is similar in nature to Dynamic Light Scattering (DLS) but where DLS analyses light scattered at fixed angles for a fixed wavelength, LTS measures the transmittance spectra across a range from 210 to 2300nm. This provides a much better signal to noise ratio than DLS or other similar techniques. The LTS system thus has potential for many further applications in environmental and biomedical settings. In this work, mixtures of polystyrene beads were used to assess the capabilities and limitations of the LTS system - with the ultimate goal of being able to successfully measure the particle size distribution of an unknown complex polydisperse solution.

It was first necessary to understand the limitations of solutions with particles of one size. In order to do this solution were made up of particles ranging from 50nm to 3000nm and beginning with suspensions of high particle concentration diluted down in order to obtain the maximum and minimum concentrations at which an accurate size and density could be measured. The results are shown in Figure 1.

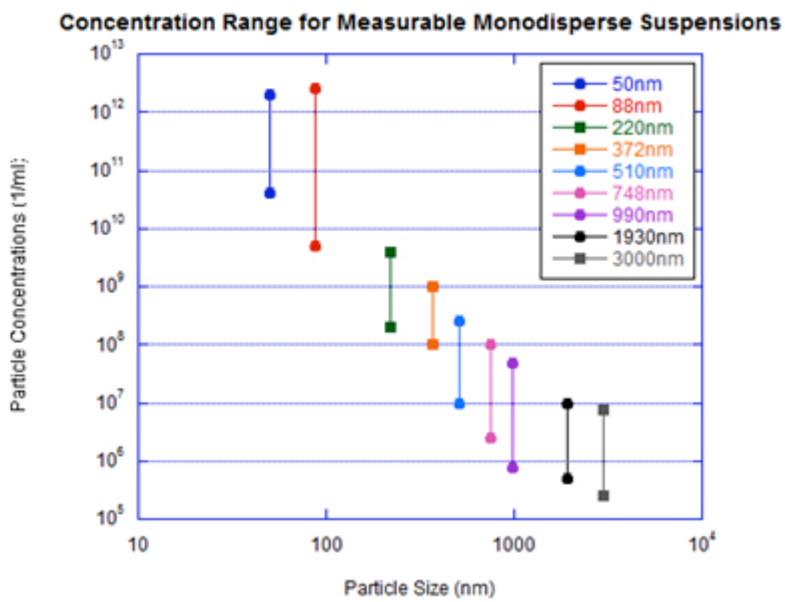

Figure 1 Measurable Ranges for Monodisperse particles

As polystyrene has been found to have similar dielectric properties to organic materials, it is an ideal and cost-effective material for approximating the behaviour of such samples. It was then necessary to assess mixtures of particles in suspension. A number of mixtures were assessed with the overall aim of building a standard against which unknown solutions can be measured and the particle size distribution obtained.

We explored the size range a polydisperse solution could have before filtration methods have to be introduced. Syringe filtering was then explored as a method for separation in an attempt to isolate these acceptable ranges.

We found that there are limits to how far apart and how close together in size particles can be before problems arise in detecting their presence in mixtures. However, understanding the limitations of the system and building a procedure than can be used to accurately find the particle size distribution of an unknown solution will provide next stops to implementing this system in practical environmental and biomedical settings.